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THE OPERATIVE TREATMENT OF FRACTURES, ESPECIALLY OF THE LONG BONES.

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When a surgeon is called upon nowadays to treat a patient with a fractured femur, for example, the problem which immediately confronts him is whether to operate or not to operate. There was a time long gone by when the question of operation in such cases never arose unless it was a question of amputation or resection; operation for the purpose of putting the broken fragments in proper relationship with one another was not considered, since the proper adjustment of the fragments was thought to be done by extension, counterextension, and manipulation. The Röntgen rays have shown that most fractures of long bones set in this way have resulted in shortening due to overlapping of the fragments.

The question may be asked, Why should we operate on fractures which are almost certain to get well without operation? The answer is, For several reasons: (1) To prevent deformity of a limb, especially shortening, which is of the greatest importance in the lower limbs; (2) to prevent loss or impairment of function, as of pronation or supination; (3) to obviate delayed union or ununited fracture; (4) to give opportunity to repair the soft tissues—nerves, muscles, and bloodvessels; and (5) because, as a rule, it is the only way to get a perfect result. It is now generally agreed that for a fractured patella or olecranon the operative is the best treatment.

I believe that perfect adjustment in fractures of the long bones is seldom accomplished without operation, except in green-stick fractures and some transverse fractures in which the fragments may be only partially displaced and have not overridden, as in some Colles fractures. It is also often impossible to ascertain, after a supposed reduction, whether or not apposition has been obtained. In the case of a broken femur surrounded by muscles from two to four inches in thickness, who by palpation can tell anything about the relations of the fragments? We resort to measurement: a mistake of one-half to three-fourths of an inch may easily be made on account of the broad or flat bony prominences between which we measure. The grating of bony fragments and the result of measurement may indicate complete reduction, but its stability cannot be depended on: the fragments may be touching each other over the smallest fraction of an inch, and this contact may be broken at any moment by the slightest movement of the limb, and shortening may be reproduced. By exposing the site of the fracture by incision, and then having extension and counterextension made while I manipulated the naked ends of the fragments, I have repeatedly demonstrated the great difficulty of reducing by extension and counterextension fractures of the humerus, radius, ulna, femur, and tibia in which the ends of the bones overlapped. In transverse fractures it has often been necessary to bring the ends out of the wound, in partial contact with one another, making an angle like the rafters of a roof, then by straightening the limb the ends of the fragments would be brought in full contact with each other. In oblique fractures, even with the aid of the lion-jawed and other bone-holding forceps, I have sometimes been unable to get perfect reduction and have had to fasten the fragments together with a fourth of an inch shortening. In a patient with fracture of the middle of the shaft of the femur treated for a few days on the double inclined plane, operation revealed an overriding of two inches and a separation of the fragments from each other by muscular tissue one inch in thickness.

It is the opinion of many that Buck's and other kinds of extension can correct the shortening. It may diminish the shortening, but in the majority of cases I believe it cannot correct it fully. I treated a man, sixty years old, with a fracture in the upper third of the shaft of the femur, on a double inclined plane, with extension in a line with the femur with a weight of sixty pounds, without getting complete reduction. The method by operation was explained to him, but he preferred the other and made a good recovery, with one inch and a half shortening of the femur.

If there is anything in the theory that union of bone is hindered or prevented by the intervention of soft tissues, too much motion, or lack of accurate approximation, operation properly performed surely must often prevent delayed union. I say properly performed, because otherwise it seems possible to increase the danger of delayed union. For example, too extensive detachment of the soft parts with the periosteum from the fragments may cause necrosis. In some cases in which union has taken place in bad position and it has been necessary to operate, delayed union may result. The resources of the tissues seem to have been exhausted in the formation of the callus for the first union; whence they are unequal to the second task imposed upon them.

The dangers of the operative method must be carefully considered. That means the dangers which come by reason of the operation, and not those which attend fractures treated in other ways: (1) Anesthesia. This is not peculiar to the method by operation, but is in general use in the treatment of fractures. (2) Fat embolism. As shown by Connell and others, this occurs in nearly all fractures of large bones containing much fat, and is probably dangerous only when the amount of fat taken up by the capillaries is large—a condition likely to be brought about by much manipulation of the fragments, and therefore equally as likely to result from efforts to reduce a fracture by the blind as by the open method. (3) Extensive detachment of the periosteum and other soft parts must be avoided as already mentioned. (4) Infection. This is the chief danger, as the others mentioned are common to any method in which anesthesia is used, and in modern surgery this should not be great.

TECHNIQUE. Of the various means used to hold the fragments of bones together, such as plates, screws, nails, ivory pegs, bone ferrules, animal sutures, and wire, I believe the wire the best in a large majority of cases. It is less bulky, it can be applied with much less injury to the soft parts than some of the others—the metal plates, for example—and its action in holding the bones together continues longer than any of the other methods except the bone ferrule. The nails and screws soon cause softening of the bone in which they are embedded, and the bone ferrule is not satisfactory according to my limited experience. It is not always necessary to wire the fragments or to use sutures. Transverse fractures, once perfectly reduced, remain in position by the use of splints, but it is safer to wire them. Kangaroo tendon, silk, and heavy catgut may do in some cases, but as a rule wire is better, because it is stronger and is not absorbed too soon. No matter how much care may be used to keep the ends of the bones together, some force, as the contraction of muscles, will tend to displace them, and this force may continue to act after animal sutures have been absorbed. Recently I have been using iron wire. It has the advantages over silver wire of being much stronger and cheaper, it does not seem to irritate the tissues or to be more often followed by suppuration than silver wire, and I believe it is possible in time for the iron wire to corrode away and disappear.

Wire may be used in several ways: (1) In transverse fractures each fragment is drilled through at right angles and two strands of wire are used (Fig. 13). (2) Only one hole is drilled in each fragment and only one loop of wire is used (Fig. 6). (3) The drill-holes do not pass through the bone, but only enter the medullary cavity (Fig. 5). The first of these methods gives the greatest security against displacement. (4) In oblique fractures the fragments may be drilled through while in position, the wire passed through, and then carried several times around the fragments. (5) The wire may simply be carried several times around the fragments after adjustment, without drilling (Figs. 2, 3, and 4), or it may be carried around the fragments in position at two or more points (Fig. 2).

For carrying wire around bones so as to injure the soft parts as little as possible, I have had a strong, full-curved needle made in three sizes. For holding the fragments in position while drilling or wiring, Foraboeff's bone-holding and the lion-jawed forceps are indispensable. For drilling the bone a drill with a handle like a gimlet is the most satisfactory. All hemorrhage having been arrested and the wound closed, the best splint is plaster-of-Paris, but a window must be cut—through which one may observe the progress of the wound in the soft parts.

CASES. In my note-books I find histories of 102 cases of fracture in which I have operated, as follows: Superior maxilla 4, inferior maxilla 12, clavicle 5, humerus 10, radius and ulna together 5, radius alone 1, ulna alone 10, femur 13, patella 20, ruptured patella tendon 1, ruptured quadriceps extensor 2 (these three cases are placed next to fractures of the patella, to which they are nearly allied), tibia 16, and fibula 3. There were two deaths, both after operation on the neck of the femur; they will be considered later.

Superior Maxilla. The fractures of the superior maxilla were bilateral and complicated with fracture of the bodies of the palate bones and of the pterygoid processes of the sphenoid, the line of fracture passing through the superior maxillæ from the front backward through the nasal fossæ and the antra of Highmore, above the palate processes, through the body of the palate bones and the pterygoid processes, so that the entire alveolar arch and palate dropped slightly and were freely movable. In one case the two maxillæ and palate bones were separated from their fellows in the median line. The causes of these fractures were street railway accidents in 2, and blows across the front of the upper jaw in 2. There was no difficulty in obtaining union, though one was complicated with an abscess of the antrum of Highmore.

Lower Jaw. The fractures of the lower jaw were all through the body of the bone and the alveolar process, most of them oblique; the transverse fractures were usually treated with bandages and splints only. The line of fractures should be exposed by an incision along the lower border of the body of the jaw and the soft parts stripped off until the bone is exposed on each side of the line of fracture sufficiently for drilling a hole. Care should be taken not to injure the mental nerve at its exit from its foramen, nor the branches of the cervicofacial division of the seventh nerve near the angle of the jaw. It may be necessary to ligate and divide the facial artery. The holes in the fragments should be drilled as near to the line of fracture as is safe, and low enough not to injure the teeth roots or the inferior dental nerve. The wire should then be introduced, twisted until the fragments of bone are in apposition, the ends cut off, and the twisted part turned beneath and to the inner side of the bone. The teeth should be wired, if practicable, passing the wire around the teeth two teeth distant from the line of fracture, twisting the wire on the outer side of the teeth, and turning the end down against the gum so that it will not irritate the lip (Fig. 1). These twelve patients all made good recoveries.

Clavicle. The fractures of the clavicle, five in number, were all treated by incision, exposing the parts, putting the fragments in place, and holding them by wrapping them with catgut, kangaroo tendon, or silver wire. This was done by means of a large, full-curved needle, carrying the thread around from three to eight to ten times. Care was taken to separate the muscle attachment as little as possible, both to avoid necrosis and also to afford tissue which would prevent the thread which is passed through it from slipping. In no case was it necessary to drill the fragments. The results were all good, and there was no shortening (Figs. 2, 3, and 4).

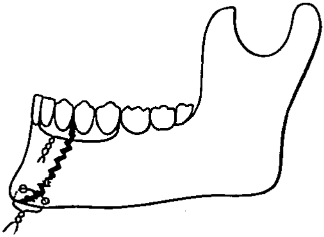

FIG. 1.—Fracture of left side of the lower jaw, showing the wires in place—one through holes drilled in the lower part of the body of the jaw, the other around the teeth.

Humerus. Of these, 10 were operated on: 2 of the neck, 1 of the middle third of the shaft, 3 supracondylar, 2 T-fractures, and 2 condylar fractures. One of the neck fractures (Case VIII) occurred in a man, twenty-five years old, who fell from a step-ladder a height of about four feet, and struck on his right shoulder. Examination showed swelling and the projection upward and inward, in front of the acromion process, of the upper end of the lower fragment, as in epiphyseal separation; a diagnosis of fracture of the anatomical neck was made. The parts were exposed by an incision from the anterior part of the acromion process downward in line with the humerus, splitting the fibers of the deltoid to the outer side of the long head of the biceps and the attachment of the pectoralis major, cutting and tying a few branches of the circumflex arteries, and exposing the circumflex nerve, but pushing it out of the way. On retracting the soft parts the fracture was exposed. The principal line of fracture ran from the anatomical neck in front downward, inward, and backward, for an inch and a half obliquely, through the bone, separating the tuberosities from each other—the greater tuberosity remaining with the upper fragment, the lesser forming the upper end of the lower fragment. A fragment about half an inch-square was broken from the greater tuberosity, but was held in position by the fibrous tissue. The joint was not opened. The displacement was easily reduced by traction on the arm; a hole was drilled in each fragment into the medullary cavity, and a piece of silver wire was put in and twisted, thus holding the fragments in exact apposition (Figs. 5 and 6). The wound was closed without drainage and the arm was bound to the side with a sling for the forearm. There was primary union of the soft parts, and forty-five days later there seemed to be bony union with good result—motion, shape, etc., being normal. A skiagram showed the parts in normal position.

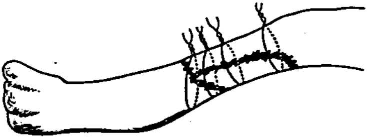

FIG. 2.—Fracture of the left clavicle at the junction of the middle and the outer third, with the production of three fragments. These were adjusted and held in place by four kangaroo ligatures encircling the fragments; two of the ligatures were placed obliquely. (Case 1. book 2, page 49.)

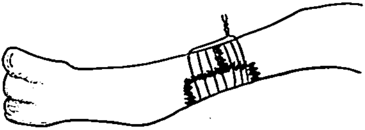

FIG. 3.—Fracture of the left clavicle (three pieces), showing the silver wire carried around the fragments. (Case IV, book 6, page 130.)

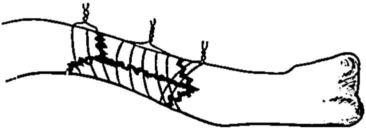

FIG. 4.—Fracture of the right clavicle (the middle third broken into four fragments), showing wire at the ends passed obliquely around the fragments and through the muscular attachments to prevent slipping. (Case V, book 6, page 136.)

Case IX was a compound transverse fracture of the surgical neck of the left humerus in a boy eighteen years old. The wound in the soft parts was two inches below the shoulder-joint and a little to the outer side of the anterior surface. The wound was enlarged above and below, about in line with the middle of the acromion process along the outer surface of the humerus, splitting the deltoid, securing the branches of the circumflex arteries, and avoiding the nerve. There was overlapping of more than an inch—the lower fragment lying to the outer side of the upper fragment. The line of fracture was transverse, with a short spicule attached to the inner side of the lower fragment. There was considerable difficulty in getting the ends together in spite of traction and the use of bone-holding forceps. Once put together there seemed to be no tendency to displacement, but a hole was drilled in each fragment from side to side entirely through the bone, and heavy silver wire was passed through and twisted on the outer side. The wound was closed without drainage and dressed. There was primary union of the soft parts, and at the end of forty-five days bony union seemed to be good, motion, length, shape, etc., being normal (Fig. 7).

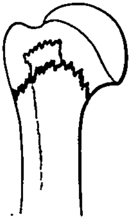

FIG. 5

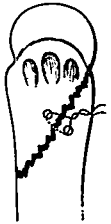

FIG. 6

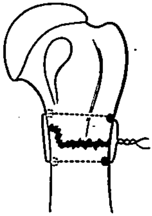

FIG. 7

FIG. 5.—Oblique fracture of the neck of the right humerus, anterior view. (Case VIII, book 6, page 101.)

FIG. 6.—Oblique fracture of the neck of the right humerus, external view, showing the length and direction of the line of fracture, and the wire in place. (Same as Fig. 5.)

FIG. 7.—Left humerus, anterior view, showing fracture of the surgical neck with the wire in place. (Case IX, book 6, page 121.)

A fracture of the middle third of the shaft was the only one which gave a bad result. This was in a sailor, forty-eight years old, who received the fracture two and one-half years before he came to me. It was operated on soon after it was received, before I saw him, but no union resulted. During the year he was under my observation, two operations were performed. The first consisted in freshening the ends of the bone and fastening them together with iron-wire nails. A small amount of bone formed, but no union took place; so that a second operation was done, this time using a bone ferrule. This remained in nearly five months and then was removed without having caused any union, although a slight amount of bone had formed. The patient declined further operation and when last seen had a false joint, a skiagram of which is shown in my book.[1]

The supracondylar fractures were treated by incision through the triceps muscle on the back of the arm, or between the brachialis anticus and supinator longus in front, and wiring of the fragments with or without drilling. All gave good results. The T-fractures and condylar fractures were exposed by one of the incisions already given and the fragments fixed by wire or nail. One case is given as an example:

Case II. Book 3, page 9. A boy, seventeen years old, fell and struck on his right elbow, causing a T-fracture of the humerus. Incision was made between the supinator longus, and the biceps and brachialis anticus, being careful not to injure the musculospiral nerve. The lower end of the upper fragment was displaced forward and inward and the condyles were split apart. The fragments were adjusted and the condyles held in place by a steel drill driven through the skin, the external condyle, and deep enough into the internal condyle to hold fast. The external condyle and the lower end of the upper fragment were then wired together after drilling a hole in each (Fig. 8). The drill was removed at the end of seventeen days. Good union followed and almost normal motion—flexion being normal, but extension only 135 degrees. There was considerable formation of callus.

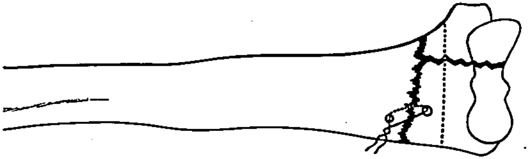

FIG. 8.—Right humerus, anterior view, showing drill through the external condyle into the internal condyle and the external condyle united to the shaft. The dotted line represents the drill. (Case II, book 3, page 9.)

Radius and Ulna. In treating fractures of the radius and the ulna, it is of the first importance to preserve the function of rotation —pronation and supination—by accurately adjusting the fragments. In fractures of the radius just above the insertion of the pronator radii teres, the upper fragment is likely to be rotated outward (supinated) and the lower fragment rotated inward (pronated). In all, 16 operations were done—5 on the radius and ulna together,

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[1] Manual of Surgery, p. 253.

1 for Colles' fracture, 1 for fracture of the shaft of the ulna, and 9 for fracture of the olecranon.

In operating on these bones the greatest difficulty is encountered in connection with the radius; the ulna can be exposed, without trouble and without endangering any important structures, by an incision at any point along its posterior border, but the radius is covered by thick muscles in its upper half and by important tendons and the radial nerve in its lower half. Two incisions are necessary when operating on both bones—one for each bone. In fracture of the upper third or of the head of the radius, the incision is best made over the outer and posterior part of the forearm from the external condyle downward over the head of the radius and in the axis of its shaft, dividing the skin and fascia, finding the intermuscular space between the extensor communis digitorum and the extensor carpi ulnaris, and dividing or separating the fibers of the supinator brevis until the bone is sufficiently exposed. The posterior interosseous nerve should be avoided. Branches of the posterior interosseous recurrent artery and other vessels from the anastomosis around the elbow-joint require ligation.

To expose the radius in the middle third, one should make an incision behind the outer border of the forearm along the inner side of the extensor carpi radialis longior, enter the space between the extensor carpi radialis brevior and the extensor communis digitorum until the attachment of the extensor ossis metacarpi pollicis to the radius is exposed. In order to expose the bone sufficiently it may be necessary to separate the attachments of this muscle and those of the pronator radii teres, and, in front, of the flexor longus pollicis. For fractures in the lower third, including Colles', the radius may be exposed by an incision along the outer border of the radius from the styloid process upward, taking care not to injure the radial nerve, which is superficial. The crossing of the carpal extensor tendons by those of the thumb makes it somewhat difficult to expose the radius in the lower third. The best plan is to separate the tendons where it seems easiest and safest in order to expose the fracture. In Colles' fracture, I found it easier to open the "snuffbox"—the space between the extensor longus and the extensor brevis pollicis tendons—exposing the tendons of the extensor carpi radialis longior and brevior, which were retracted to the inner or outer side as might be most convenient.

Olecranon. All fractures of the olecranon do not require operation. Cases are seen in which there is no separation of the fragments, although there is a false point of motion readily detected by making lateral pressure. The fibrous expansion of the triceps tendon, corresponding to the quadriceps expansion about the patella, remains unruptured and holds the upper fragment in place. Separation of a quarter of an inch or more requires operation.

The site of fracture should be exposed by a longitudinal incision over the olecranon. The elbow-joint is usually opened and is often filled with blood clots, which should be washed away with salt solution. The fragments should be adjusted and can usually be fixed in position by sutures of kangaroo tendon through the fibrous tissue covering the bone. Wire may be used, especially when the soft parts are destroyed to such an extent that sutures will not hold. The wire should not enter the joint, the fragments being drilled obliquely as in the patella, two holes in each fragment; or if preferred, the fragments may be drilled laterally where they are thicker and a single strand of wire used. I have used about equally kangaroo tendon and wire, with good results in all. The limb should be dressed and the forearm carried in a sling at right angles; it is not necessary to put up the forearm in extension.

Femur. Thirteen fractures of the femur were operated on: 4 of the neck, 6 of the shaft, and 3 of the lower extremity, including 2 T-shaped fractures and 1 epiphyseal separation. It may be well to give a brief account of these cases as showing both the good and bad results following treatment:

Case I.—A man, aged twenty-five years, sustained a fracture of both femurs in the middle third, the left being compound. The left femur (the compound fracture) united in the usual time, but with two inches of shortening, while the right femur refused to unite. It was operated on, a false joint being found. One inch of bone was sawed from each fragment in order to make the femur correspond in length with its fellow; the bones were drilled and fastened with one strand of silver wire. The patient made a good recovery, with legs of equal length, but his stature had been diminished two inches.

Case II.—A man, aged twenty-five years, sustained a fracture of the right femur in the middle third—upper part. He was operated on the same day through an external incision. The fracture was almost transverse; each fragment was drilled laterally and united by one piece of heavy silver wire. Suppuration followed, but final recovery, with good result, was secured.

Case III.—A girl, aged eleven years, had an epiphyseal separation of the lower end of the left femur, the result of a wagon-wheel passing over the limb. The usual symptoms presented: great swelling of the knee, floating and prominence of the patella, with an abnormal depression above it, hardness in the popliteal space, and shortening of the femur (Fig. 9). Attempts to reduce the displacement without incision failed, so the parts were exposed by an incision along the outer side of the knee. The patella was found resting on the epiphysis and the epiphysis on the anterior surface of the lower end of the diaphysis. Reduction was accomplished with some difficulty by flexing the leg, making traction on the flexed leg, and by pressure. The wound healed without trouble, after which the patient passed from under my observation.

CASE IV.—A woman, aged sixty-five years, fell, causing a T-shaped fracture of the lower end of the left femur. Attempts to reduce the fragments failed, so that an incision was made along the outer side of the thigh and knee in front of the biceps tendon, exposing the lines of fracture. The fracture was just above the condyles and transverse except for a long spicule which projected from the upper fragment and was embedded in the soft tissues just above the patella. The fractured surface of the condyles presented backward toward the popliteal space. The condyles were split apart, but were held together by the soft tissues. A hole was drilled through the upper fragment and one through each condyle anteroposteriorly; a piece of silver wire was passed through the holes in the condyles and through the hole in the upper fragment, using a piece of wire for each condyle, but both pieces passed through the one hole in the upper fragment (Fig. 10). Plaster-of-Paris was applied with the knee slightly flexed. There was no trouble, and the result was good.

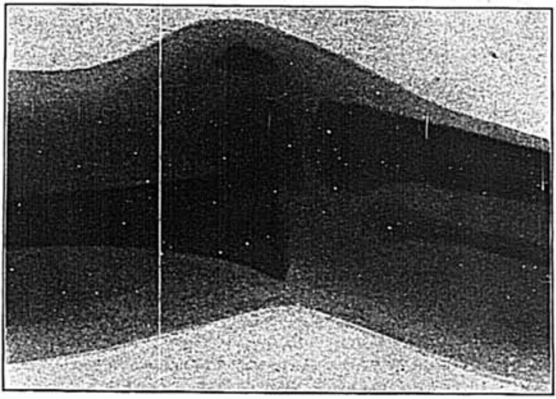

FIG. 9.—Epiphyseal separation of the lower end of the femur.

CASE V.—A man, aged twenty-eight years, fell from a platform and suffered a compound T-shaped fracture of the right femur—the lower end of the upper fragment projecting through the skin of the front and inner side of the thigh about two inches above the knee. The incision was enlarged above and below, whereupon the fracture was found to be oblique from above downward and forward. There was also a line of fracture between the condyles, which were movable one on the other, but did not fall apart laterally.

The fragments were accurately adjusted and wrapped with silver wire (Figs. 11 and 12). A good result followed.

Case VI.—A girl, aged six years, sustained a fracture of the left thigh in the upper part of the middle third; she was treated by vertical suspension; after six weeks there was union with two inches of shortening. Through an external incision a fracture, oblique from above downward and outward, was found. The union was broken up, the parts almost perfectly reduced, and wrapped with silver wire. Healing and union followed, but there was half an inch shortening.

Case VII.—A woman, aged sixty-three years, had fractured the neck of the left femur seven years before and had been treated for some years for sciatica and other troubles before the diagnosis of fracture was made. Operation was undertaken on account of great and constant pain. An anterior incision exposing the hip-joint was made; no union; no callus was found; the head and neck were softened and were removed in fragments. The result was good—complete relief from pain and improved locomotion.

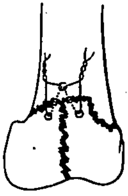

Fig. 10

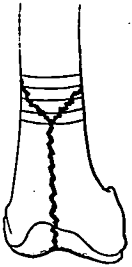

Fig. 11

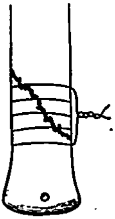

Fig. 12

Fig. 10.—Anterior view of T-shaped fracture of the left femur, showing wires in place. The projecting spicula was cut off. (Case IV, book 4, page 12.)

Fig. 11.—Anterior view of T-shaped fracture of the right femur, showing the wire in place. (Case V, book 5, page 94.)

Fig. 12.—Lateral view of the fracture shown in Fig. 11.

Case VIII.—A man, aged twenty-four years, sustained a compound fracture of the right femur in the middle third, a fragment projecting through the skin of the outer and posterior surface of the thigh. The wound was enlarged and a second incision to the outer side of the rectus muscle was made. There was considerable laceration of the muscles and three loose fragments of bone were removed. The lower fragment was posterior and external to the upper fragment and separated from it by muscular tissue at least one inch in thickness. The fracture was transverse. The ends were drilled and wired together end-to-end. The patient had a severe attack of suppurative tonsillitis four weeks after the operation. The wounds in the soft parts healed without trouble and there was considerable callus formed by the end of the second month, but there has been delay in ossification, so that even now, eight months after the operation, there is slight motion at the point of fracture, which very slowly diminishes.[3] The femur is full length.

CASE IX.—A man, aged twenty-one years, fractured his right femur in the upper part of the middle third. An external incision exposed a very oblique fracture over two inches long from above downward and inward, the lower fragment lying in front and to the outer side of the upper. The fragments were adjusted and wrapped with wire. Union followed without trouble in five weeks, but there was half an inch of shortening, evidently caused by slipping of the fragments. It would have been better to drill the fragments, pass the wire through, and then wrap well with the wire. This would probably have prevented shortening.

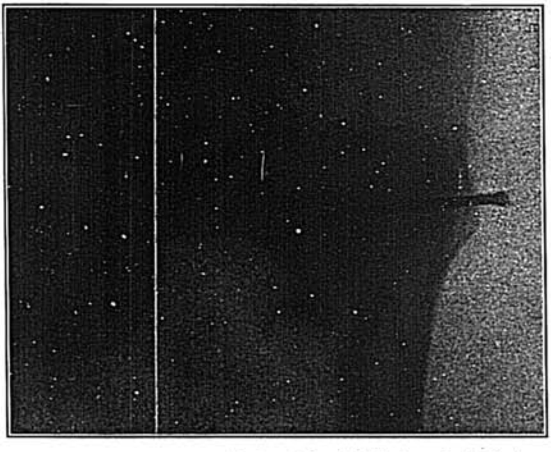

FIG. 13.—Skiagram of a fracture of the base of the neck of the femur, showing the iron nail used to retain the fragments in place.

CASE X.—A man, aged thirty-one years, fell from a height of ten to twelve feet and struck on the right trochanter major, causing a fracture of the base of the neck. An anterior incision exposed the neck and upper part of the shaft, showing the line of fracture to correspond with the anterior intertrochanteric line, outside the capsule of the joint and leaving the trochanter major attached to and forming the summit of the lower fragment. The lower fragment had slipped up about one inch, but by traction this was brought down. An incision was made through the skin over the trochanter and a three-inch iron-wire nail was driven through the trochanter at its lowest part, into the neck of the femur (Fig. 13). There seemed to be good union at the end of four weeks, but the patient was not permitted to walk until six weeks had elapsed, and was told not to bear any weight on that leg until three months had passed. The result was good; about one-quarter inch shortening; motion and function of the joint are normal. The nail is still in the bone.

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[3] This patient had fully recovered a month later.

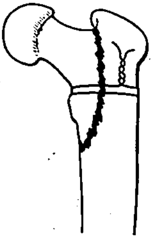

Fig. 14.—Anterior view of an intertrochanteric fracture of the left femur, showing the fragments adjusted and two turns of heavy wire in place. (Case XI, book 6, page 104.)

Case XI.—A woman, aged seventy-five years, suddenly sat down on the floor and fractured the left femur. Under chloroform the upper end of the femur was exposed by an anterior incision. There was fatty degeneration of the muscles and the bone was thinner and more porous than normal. The line of fracture extended from the inner side of the trochanter major downward and inward, a little to the outer side of and diverging from the anterior intertrochanteric line, reaching the inner side of the shaft nearly an inch below the trochanter minor—thus separating the trochanters. The lower fragment lay to the outer side of and behind the upper fragment. The capsule was not opened. No difficulty was met with in adjusting the fragments accurately and in carrying a piece of heavy silver wire twice around the fragments between the trochanters (Fig. 14). The wound was closed without drainage. That night the patient became delirious, the pulse rapid and weak, and death occurred forty hours after the operation. Death was thought to be due to fat embolism lodging in the brain. Unfortunately, no necropsy was made.

CASE XII.—A boy, aged eleven years, had his left femur fractured in the lower part of the middle third. An incision along the outer border of the rectus muscle exposed the fragments. There was overlapping of two inches, the lower fragment lying to the inner side and posterior to the upper. The line of fracture was nearly transverse. The ends of the fragments were adjusted with considerable difficulty, then two holes were drilled through each fragment—one from before backward, the other from side to side—and two pieces of wire were put in and twisted. The wound was closed without drainage. A good result was obtained in fifty days, with no shortening or deformity (Fig. 15).

CASE XIII.—A man, aged about fifty years, broke the neck of his right femur. An anterior incision showed the line of fracture almost exactly along the anterior intertrochanteric line, the head, neck, and lesser trochanter being separated from the shaft and greater trochanter. The fragments were adjusted and drilled, the holes going only to the interior of the bone, and wired. The wound was closed without drainage. Three days later the patient had a general convulsion. Next day the wound was opened and considerable thin fluid or serum with offensive odor escaped. The patient did not improve; his mental condition was confused, the pulse rapid, and death occurred five days after the operation and forty-eight hours after the convulsion—probably from fat embolism in the brain. No necropsy was permitted.

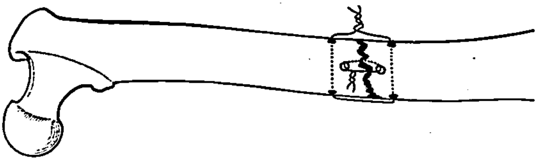

FIG. 15.—Anterior view of a fracture of the middle third of the left femur, showing the fragments adjusted with two strands of wire through holes at right angles to each other. (Case XII, book 6, page 108.)

Both these deaths have been attributed to fat embolism, as the symptoms were similar and in general indicative of that condition, although in neither case were there pulmonary symptoms. Case XI might have been attributed to chloroform poisoning, but ether was used in Case XIII. Every surgeon knows that death is not infrequent as a result of fractured femur, probably caused most frequently by fat embolism, and it is quite likely that the ordinary efforts to reduce the fractures in these two patients without operation would have been followed by the same unfortunate result.

For exposing the femur, I prefer the following methods:

Upper Third. Make an incision, four to eight to ten inches long, from half an inch below the anterior superior spinous process of the ilium downward, in line with the outer border of the patella, cutting into the angle formed by the divergence from each other of the sartorius and tensor vaginæ femoris, to the outer side of the rectus, between it and the gluteus medius and minimus. If the fracture is below the trochanters, the vastus externus must be drawn outward and the fibers of the crureus divided and retracted to expose the bone. From three to six branches of the external circumflex artery require ligation. To examine the neck of the femur within the capsule, it is necessary to separate the psoas and iliacus from the capsule and draw them inward with the rectus, and then split the capsule in line with the long axis of the neck.

Middle Third. Make an incision along the middle third in the line which separates the anterior from the external surface of the thigh, find the outer border of the rectus muscle, draw it inward and the vastus externus outward, and divide the fibers of the crureus, which are closely attached to the bone, until it is exposed to a sufficient extent.

Lower Third. Make an incision from the anterior portion of the outer condyle of the femur upward along the outer side of the thigh, exposing and splitting the vastus externus until the bone is exposed. Several arteries from the anastomosis around the knee will require ligation. Care must be taken not to injure the popliteal vessels and nerves or inadvertently to open the synovial cavity of the knee.

Patella. Twenty operations were done for fracture of the patella; the results were all good. One patient only had fibrous union, and this was the result of a Barker operation—a subcutaneous surrounding of the fragments by a silk ligature passing through the joint. The usual operation was a horseshoe incision, wiring the fragments after drilling, union of lateral fibrous expansion with kangaroo tendon, and closure without drainage. The patients were confined to bed for two or three weeks; care in using the knee was insisted upon, motion being limited for three months by means of a bandage or pad.

In addition, there were two ruptures of the quadriceps extensor and one of the patellar tendon; in all three cases the tendon gave way at its attachment to the bone. Kangaroo tendon was used to suture the part in position. The results were good.

Tibia and Fibula. Sixteen tibias were operated on and three fibulas, with good results; but one is still under treatment. Many of these were compound comminuted fractures. Usually, only the tibia was wired when both bones were broken and the ends of the fibula simply adjusted, sometimes wrapped with wire (two cases), but never drilled. To expose the bones an incision is made half an inch to the outer side of the crest of the tibia. Often both bones can be treated through this incision. Care must be taken not to injure the anterior or the posterior tibial vessels and nerves. If a separate incision is necessary to expose the fibula, this may be made at any point along the line of the fibula from the head to the external malleolus, entering the space between the extensor longus digitorum on the inner side and the peroneal muscles on the outer side, being careful not to injure the musculocutaneous nerve, or, if the operation is near the head of the fibula, the peroneal nerve. Often the position of the incision is determined by a wound already existing in the soft parts. In one case the styloid process and insertion of the biceps were broken from the fibula by muscular action (wrestling). Suture with kangaroo tendon gave a good result.

LEUKEMIC BLOOD PICTURE IN A CASE OF FRACTURE OF THE ANKLE.

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Reports upon the blood findings in cases of fracture are so scarce that it is difficult to form a definite opinion of the frequency with which abnormalities occur. Cabot[1] states that a study of thirty-eight cases, by himself, Hubbard, and Blake, of which fifteen were complicated, showed nothing abnormal. From the figures given, however, it is clear that in a certain percentage of the cases the leukocytes were increased. Ewing and Da Costa give no original observations, and Grawitz also makes no special mention of the findings in fractures. A survey of the journal literature of the past few years likewise brought no data to light. Hastings writes me that in two cases he has seen "myelemia," with myelocytes between 3 and 7 per cent., the one being a severe crush of the thigh (and femur), and the other one of the forearm, with no break in the skin and no evidence of infection.

In view of these meager data the following case report may not be out of place: The patient was a colored man, aged forty-five years, who was admitted, on October 18, 1905, to Dr. Johnson's service at the Maryland General Hospital, with a compound fracture of the right ankle. Careful questioning did not bring out any information which would suggest that the patient had been the subject of myeloid leukemia previous to the accident. He had noticed no lump in the abdomen and had been in his usual strength up to that time.

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[1] Pathology of the Blood, 5th ed. p. 400.